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SPECIFICATION FOR STABILIZED POWER SUPPLIES, DC OUTPUT

PART I TERMS AND DEFINITIONS

(Second Reprint JANUARY 1996)

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NEW DELHI 110002

Gr 5

October 1974

Indian Standard

SPECIFICATION FOR STABILIZED POWER SUPPLIES, DC OUTPUT

PART I TERMS AND DEFINITIONS

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Indian Standard
SPECIFICATION FOR STABILIZED POWER SUPPLIES, DC OUTPUT
PART I TERMS AND DEFINITIONS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 8 January 1974, after the draft finalized by the Power Convertors Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 Indian Standard Specification for stabilized power supplies is being prepared in four parts. This part covers terms and definitions only. The other parts are as under:

Part II	Rating and performance
Part III	Radio interference tests
Part IV	Tests other than radio interference

0.3 In the preparation of this standard, assistance has been derived from IEC Document No. 22E (Central Office) 4 ' Draft Recommendations for Stabilized Power Supplies, DC Output — Part 1 : Terms and Definitions ' issued by the International Electrotechnical Commission.

1. SCOPE

1.1 This standard (Part I) covers definitions applicable to stabilized power supplies designed to supply dc power from an ac or dc source for applications, such as in computers, communication, laboratories and industry.

1.2 Calibrated stabilized power supplies for electrical measurement purposes are excluded.

2. GENERAL TERMS

2.1 Source — A point of origin of electrical energy. In this standard it is used as an adjective to describe the input to the equipment.

2.2 Influence Quantity — Any quantity generally external to a power supply, which may affect its performance.

2.3 Stabilization — The reduction of the effect of changes of influence quantities on the output quantity by means inside the power supply.

2.4 Stabilized Power Supply — An apparatus which takes electrical energy from a source and supplies it in a stabilized form to one or more pairs of output terminals.

2.4.1 *Constant Voltage Power Supply* — A power supply that stabilizes output voltage with respect to changes of influence quantities.

2.4.2 *Constant Current Power Supply* — A power supply that stabilizes output current with respect to changes of influence quantities.

2.4.3 *Constant Voltage/Constant Current Power Supply* — A power supply that operates as a constant voltage power supply or constant current power supply depending on load conditions.

2.5 Crossover Area — The range of values of the output quantities within which a change of mode of operation occurs.

NOTE 1 — Within this area, the output quantities are not well defined.

NOTE 2 — Unless otherwise specified, the crossover area is given by the overlap of the load effect bands or of the tolerance bands.

2.5.1 *Crossover Point* — A point given by the intersection of the lines representing the nominal values of the two stabilized output quantities, usually the centre of the crossover area.

2.5.2 *Adjustable Crossover* — A feature of a constant voltage/constant current power supply whereby the nominal values of the two stabilized output quantities can be adjusted independently within the range of the rated values of the power supply.

2.6 Control — The determination of the power supply output by means of a variable element or signal, the relevant value of which may be changed continously or in steps, to change the value of the stabilized output quantity accordingly.

2.6.1 *Local Control* — The determination of the power supply output by means of a control element integral with the power supply.

2.6.2 *Remote Control* — The setting of the power supply output by means of an external control quantity.

NOTE — In general, particular modes of remote control shall be designated according to the applied signal or signal quantity, such as resistance control, conductance control, voltage control, current control and digital control.

2.7 Remote Sensing — A means by which the power supply monitors a stabilized output quantity directly at the load using extra ‘ sensing ’ leads.

NOTE — Usually, the remote sensing leads monitor voltage directly at the load, and the resulting circuit action compensates for voltage drops in the load leads up to a specified limit.

2.8 Reference Source — The source of an electrical quantity, the value of which is referred to in closed loop stabilization.

2.9 Power Factor — The active source power divided by the apparent source power.

2.9.1 *Displacement Factor* — The active source power of the fundamental waves divided by the apparent source power of the fundamental waves.

NOTE — Displacement factor is also equal to the cosine of the phase angle separating the fundamental components of source voltage and current.

2.10 Inrush Current — The maximum instantaneous value of the input current to the power supply when switching on the power supply.

2.11 Source Distortion — The deviation of the source voltage or current from an ideal sine wave of the same rms value.

NOTE — Source distortion may be expressed using quantities, such as total harmonic content, individual harmonic content, and instantaneous amplitude deviation, its duration and rate of change.

2.11.1 *Source Current Distortion* — That distortion of the source current resulting from the power supply presenting an impedance to the source or due to a change in impedance which varies with time.

2.11.2 *Source Voltage Distortion* — That distortion of the source voltage which exists without the power supply being connected.

2.11.3 *Total Source Voltage Distortion* — The source voltage distortion together with that resulting from the interaction of the source current distortion with the source impedance.

2.11.4 *Voltage Unbalance* — In a polyphase system, a condition in which the rms value of at least one phase voltage or line-to-line voltage is significantly different from the others.

NOTE — Unbalance can be expressed using quantities defined in the other Indian standards on electrotechnical vocabulary, such as the use of symmetrical components.

2.12 Efficiency — The total output power divided by the active input power.

2.12.1 *System Efficiency* — The total output power divided by the active input power, where the input power includes the power required to operate any auxiliary devices which are essential for operation.

2.12.2 *Conversion Factor* — The ratio of the product of the mean values of direct voltage and direct current to the power on the ac side, or *vice versa.*

3. TERMS RELATED TO PHYSICAL AND ENVIRONMENTAL ASPECTS

3.1 Ambient Temperature — The temperature of the medium in which the power supply is immersed, usually the temperature of the air surrounding the power supply.

3.2 Cooling Medium Temperature — The temperature of the cooling medium when meeting the power supply, for example, in the case of air cooling, the temperature of the air immediately at the air inlet.

3.3 Thermal Equilibrium — A state under which the internal temperature of a power supply does not change significantly.

3.4 Capacitance to Frame — The capacitance measurable between a specified terminal and a common point, such as frame, guard or ground.

3.4.1 *Capacitance to Source Terminals* — The capacitance measurable between the specified source terminals and output terminals.

NOTE — Sometimes referred to as 'leakage capacitance'.

3.5 Insulation Resistance — The resistance measurable between any specified points not conductively connected.

3.5.1 *Insulation Test Voltage* — The ac or dc voltage applied between specified points not conductively connected, and maintained for a specified period of time without breakdown or flashover.

3.6 Isolation Voltage — In the case of a floating output, input, or control input, the maximum voltage that may be permanently maintained between the specified terminals.

3.7 Common Mode Output — The electrical energy which is unintentionally supplied to an external impedance connected between the terminals of the floating output and a common point, such as frame, chassis, ground or shield. Common mode output is expressed in terms of common mode current and common mode admittance.

4. TERMS RELATED TO STATIC OPERATION

4.1 Terms related to the steady-state (or non-transient) portion of a power supply output change which results from a steady-state change of one or more influence quantities, with all other quantities held constant.

4.1.1 *Steady-State Value* — The value of a quantity which persists after all non-recurring transients have decayed to an insignificant magnitude.

NOTE 1 — Steady-state values, with respect to dc input or output values, mean the average values unless otherwise specified.

NOTE 2 — Steady-state values referred to the ac side mean the rms values unless otherwise specified.

4.2 Nominal Value — The value which exists 'in name only', not the actual value. For example, in the case of a power supply with a calibrated output control, the nominal output is the value indicated by the control setting. For a supply with a fixed output, the nominal output is the output indicated on the nameplate. For ac line input voltages, the nominal value is usually the 'design central' value. For example, the nominal value of a 115V ± 10 percent line voltage is 115 volts. In the case of remote control, the nominal value is the output value predicted by the remote control coefficient.

4.2.1 *Error* — For a power supply, the error is the true value of the stabilized output quantity minus its rated or preset value.

4.2.2 *Intrinsic Error* — The error under reference conditions.

4.2.3 *Operating Error* — The error under rated operating conditions.

4.3 Output Effect — The change in the steady-state value of a stabilized output quantity (voltage, current or power) due to a specified change in the steady-state value of one or more influence quantities with all other influence quantities maintained constant.

NOTE 1 — Output effects may be expressed as absolute values or relative values or a combination of both. Values given in percent shall be the percentages of the central value.

NOTE 2 — For the purposes of the subsequent definitions, the term 'output effects' is used for steady-state conditions only, whereas special terms, such as overshoot, are assigned to transients.

NOTE 3 — Output effects as defined above may include drift and thermal settling.

4.3.1 *Individual Effect* — The change of value of a stabilized output quantity, resulting from a specified change in one influence quantity, with all other influence quantities maintained constant.

NOTE — In general, abbreviated terms will be used for individual effects. Example, source effect = effect of the stabilized output quantity due to the changes of the source voltage.

4.3.2 *Interaction Effect* — The effect on an output quantity of a stabilized power supply which results from a specified change in the load or one of the other output quantities of another output of the same power supply.

4.3.3 *Combined Effect* — The maximum change in the steady-state value of a stabilized output quantity resulting from any concurrent changes in two or more of the following influence quantities within their rated ranges of use:

a) Load,
b) Source voltage,
c) Source frequency, and
d) Temperature.

Combined effect as defined above does not include periodic and random deviation (PARD), drift, settling effects and setting deviations.

4.3.4 *Combined Source and Load Effect* — The maximum effect resulting from any concurrent change in source voltage and load conditions within their respective rated ranges of use (*see* Fig. 4 on page 18).

Note — Combined source and load effect may be equal to or differ from the sum of source effect and load effect, the latter being possible because load effect may depend on source voltage and source effect may depend on load condition.

4.4 Effect Band — The range of steady-state values of a stabilized output quantity resulting from any change of one influence quantity with all other influence quantities maintained constant.

4.4.1 *Nominal Effect Band* — The steady-state values of a stabilized output quantity resulting from any change of one influence quantity within its rated range of use, with all other influence quantities maintained constant.

4.4.2 *Individual Effect Band* — The range of steady-state values of a stabilized output quantity resulting from any change of one influence quantity within its rated range of use, with all other influence quantities maintained constant.

Note — Terms, such as source effect band and load effect band, will be used (*see* Note under **4.3.1**).

4.4.3 *Combined Effect Band* — The range of steady-state values corresponding to the combined effect of several influence quantities on the stabilized output quantity (*see* Fig. 4).

4.4.4 *Combined Source and Load Effect Band* — The range of steady-state values corresponding to the combined source and load effect on the stabilized output quantity.

4.5 Output Effect Coefficient (Ratio) — The maximum change in the value of an output quantity per unit change of one influence quantity with all the other influence quantities maintained constant.

Note — Temperature coefficient is the most commonly used output effect coefficient.

4.6 Periodic and Random Deviation (PARD) — The Periodic and Random Deviation of a dc output quantity from its average value, over a specified bandwidth, with all influence and control quantities maintained constant.

Note 1 — It may be stated in rms and/or peak-to-peak values for a specified bandwidth.

Note 2 — In the case of asymmetric waveforms, a peak figure may be quoted.

4.6.1 *Psophometric Voltage* — The effective noise voltage which is defined considering human hearing, using a specified frequency weighting factor.

4.7 Drift — The maximum change of an output quantity during a specified period of time following the warm-up time, with all influence and control quantities maintained constant during the warm-up time and the period of drift measurement.

NOTE — Drift includes both periodic and random deviations over the bandwidth from zero frequency (dc) to a specified upper frequency limit. This specified upper frequency limit for drift must coincide with the lower frequency limit for PARD, so that all deviations under constant operating conditions are covered by one or the other specification.

4.8 Settling Effect — The relatively slow change of an output quantity which follows an initial change of an influence quantity and exists as an added output effect.

NOTE — This settling usually accompanies the gradual re-establishment of thermal equilibrium within the power suppply (*see* Fig. 1 on page 15).

4.9 Total Effect — The maximum change in the steady-state value of a stabilized output quantity resulting from any concurrent changes in all influence quantities within their rated ranges of use. Total effect also include PARD, drift and settling effects.

4.10 Total Effect Band — The range of steady-state values of power supply output resulting from the concurrent changes of all the influence quantities within the rated conditions of use.

4.11 Tolerance Band — The range of steady-state values of a stabilized output quantity lying between the limits of operating error (*see* Fig. 4).

NOTE 1 — Tolerance band describes the permissible deviation of a stabilized output quantity from a rated or preset value.

NOTE 2 — A statement on tolerance band is useful when a sub-division into output effects, and intrinsic errors is not of interest.

4.12 Settling Time — The time interval between a change of an influence quantity or output setting and the point where changes of an output quantity are due only to drift or PARD.

4.12.1 *Start-Up Time* — The specified initial settling time following turn-on of the power supply.

4.12.2 *Warm-Up Time* — The time interval after switching on the power supply until it complies with all performance specifications.

4.13 Settling Range — The range over which the value of the stabilized output quantity may be adjusted.

4.13.1 *Control Range* — That part of the setting range within which the power supply meets its specifications.

4.14 Discontinuous Control Resolution — In the case of discontinuous control (for example, by means of switches, wire-wound adjustable resistors) the maximum increment in the value of a stabilized output quantity arising from the smallest reproducible control element step.

4.14.1 *Incremental Control Coefficient* — The ratio of an incremental change in a stabilized output quantity to the incremental change in the control quantity or output control knob position causing it.

4.15 Control Rate — The maximum rate at which the stabilized output can be varied as a result of control quantity changes without the value of the stabilized output quantity leaving the control deviation band.

Note — The control rate is applicable only when it is essentially constant over the output control range.

4.15.1 *Control Time Constant* — The time constant which characterizes the fastest change of the stabilized output which may be accomplished without the value of the stabilized output quantity leaving the control deviation band.

Note — The control time constant is applicable only when the transition of the stabilized output quantity between its initial and final values is essentially exponential.

4.16 Control Coefficient — The ratio of the control quantity value to the intended value of the output quantity (*see* Fig. 3 on page 17).

Note — The control coefficient may vary over a range of control quantity values and is not necessarily a constant.

4.16.1 *Control Deviation* — The difference between the actual value of the output quantity and the control quantity, divided by the control coefficient.

Note — The control deviation includes non-linearity, slope error, and offset effects.

4.16.2 *Control Deviation Band* — The range of permissible values of the output quantity resulting from the control deviation (*see* Fig. 3).

4.17 Load Characteristic — The functional relationship between the value of the output voltage and the value of the output current for a specified kind of load.

4.18 Constant Voltage/Constant Current Crossover — The behaviour of a power supply that automatically converts the mode of operation from voltage stabilization to current stabilization when the output current reaches a preset value, and *vice versa*.

5. TERMS RELATED TO DYNAMIC OPERATION

5.1 Terms related to the dynamic (or non-steady-state) portion of a power supply output change, resulting from changes in influence quantities or from changes in the remote or local control setting. The adjective ' control ' may be used as a prefix to designate phenomena resulting specifically from the latter. (Example, the control overshoot amplitude).

5.1.1 *Transient Recovery Band* — A range of values of a stabilized output quantity centred about the final value of the output quantity, or centred about the nominal value in the case of a tolerance band.

In the case of a change in an influence quantity, the width of the transient recovery band is equal to the associated effect band unless otherwise stated.

In the case of a change in a control quantity, the width of the transient recovery band is equal to the control deviation band unless otherwise stated.

When the tolerance band is specified, the tolerance band serves as the transient recovery band.

5.1.2 *Transient Initiation Band* — A range of values of a stabilized output quantity centred about the initial value. Its width is identical with that of the transient recovery band. When the tolerance band is specified the tolerance band serves as the transient initiation band.

5.2 Overshoot — The transient excursion of a stabilized output quantity which lies outside the transient recovery band in the same direction as the subsequent steady-state change of the stabilized output quantity. A succeeding excursion in the opposite direction is called a negative overshoot (*see* Fig. 2A and 2B on page 16).

5.2.1 *Overshoot Amplitude* — The absolute value of the difference between the peak value of the maximum overshoot and the centre of the transient recovery band or tolerance band.

5.2.2 *Turn-On (Turn-Off) Overshoot* — The overshoot resulting from the application (removal) of the source power, or from the power supply source switch being turned-on (turned-off).

5.2.3 *Turn-On (Turn-Off) Polarity Reversal* — The transient reversal of output polarity following the application (removal) of the source power, or the turn-on (turn-off) of the power supply source switch.

5.3 Undershoot — The transient excursion of a stabilized output quantity, outside the transient initiation band, in the opposite direction of the subsequent steady-state change of the stabilized output quantity (*see* Fig. 2A and 2B).

5.4 Maximum Output Rate of Change — The maximum rate of change of an output quantity with respect to zero time, due to a change in influence quantity and/or control quantity.

5.5 Transient Times

5.5.1 *Recovery Time* — The time interval between a step change in one of the influence quantities or control quantities and the instant when the stabilized output quantity returns to and stays within the transient recovery band.

5.5.1.1 *Transient delay time* — The time interval between a step change in one of the influence quantities or control quantities and the time when the stabilized output quantity leaves the transient initiation band.

5.5.1.2 *Transient recovery time* — The time interval between the end of the transient delay time and the time when the stabilized output quantity returns to and stays within the transient recovery band.

5.5.2 *Turn-On Delay Time* — The time interval between the application of source power and the time when the stabilized output quantity first enters the output effect band.

5.5.3 *Turn-On Recovery Time* — The time interval between the end of the turn-on delay time and the time when the stabilized output quantity returns to and stays within the transient recovery band.

5.5.4 *Turn-Off Decay Time* — The time interval between the removal of the source power and the time when the output voltage falls below a specified value.

5.6 Output Impedance — The complex ratio of a sinusoidal voltage and a sinusoidal current at the output terminals, the one being caused by the other and being of external origin.

Note — This is a function of the frequency.

5.6.1 *Output Resistance* — The ratio of an incremental change of dc output voltage to an incremental change in dc output current, the one being caused by the other and being of external origin.

5.6.2 *Output Capacitance* — The capacitance between the output terminals when the power supply is not energized.

6. TERMS RELATED TO COMBINED OPERATION OF TWO OR MORE POWER SUPPLIES

6.1 Combined Operation of Power Supplies — In order to extend the output capabilities of a single power supply, two or more power supplies may be connected for a combined mode of operation. Frequently, terminals other than the output terminals may be interconnected, for example, to provide a mode of operation where one power supply (the master) may serve to control the others (the slaves).

6.2 Slave Operation — A method of interconnecting two or more stabilized power supplies and achieving coordinated control of the assembly by means of controlling the master supply alone, such combinations being characterized by essentially proportional outputs from all units.

6.2.1 *Slave Tracking Operation* — An interconnection of two or more supplies (involving one output terminal in common) with one or more slaves with outputs always held equal or proportional to the output of the master unit.

Note — The slave may be of the same or opposite polarity as the master with respect to the common output terminal; in the latter case, the configuration is sometimes referred to as complementary tracking.

6.3 Parallel Operation — The operation of two or more power supplies with all positive output terminals connected together, and all negative output terminals connected together, so that the total load current equals the sum of output current of all power supplies.

6.3.1 *Parallel Operation with Specified Load Sharing* — A parallel connection of two or more power supplies. with the total load being shared between them in a prescribed ratio.

6.3.2 *Slave Parallel Operation* — A parallel connection of one master supply, with one or more slaves with output current(s) always equal or proportional to the output current of the master unit.

6.4 Series Operation — The operation of two or more power supplies with the positive output terminals of one connected to the negative output terminal of another, so that the output voltages of the supplies are additive.

6.4.1 *Series Operation with Specified Load Sharing* — A series connection of two or more power supplies, with the total voltage being shared between them in a prescribed ratio.

6.4.2 *Slave Series Operation* — A series connection of one master supply, with one or more slaves, with their output voltage(s) always equal or proportional to the output voltage of the master unit.

7. PROTECTION TERMS

7.1 Crowbar Protection Circuit — A protection circuit which rapidly places a low resistance shunt across the output terminals of the power supply, thereby initiating action to reduce output voltage to a low value.

7.1.1 *Trip Protection Circuit* — A protective circuit which electronically interrupts the output on the occurrence of an overload.

7.2 Reset — An action by which the power supply is brought back into operation after the malfunction has been corrected. Reset may be automatic or manual.

7.3 Overcurrent Protection — Protection of the power supply and/or connected equipment against excessive output current including the short-circuit current.

7.4 Overvoltage Protection — Protection of the power supply and/or connected equipment against excessive output voltage, including the open circuit voltage.

7.5 Undervoltage Protection — Protection of the power supply and/or connected equipment against excessively low output voltage.

7.6 Reverse Voltage Protection — Protection of the power supply against reverse voltage applied at the output terminals.

7.7 Reverse Current Protection — Protection of a power supply against current fed back into the power supply by the load.

7.8 Overtemperature Protection— Protection of the power supply or parts of it against temperatures exceeding the specified values.

7.9 Current Limiting — The action of limiting the output current of a constant voltage supply to some predetermined maximum value (fixed or adjustable) and automatically restoring the output voltage to its normal value when the overload or short circuit is removed. There are three types of current limiting, namely (*see* Fig. 5 on page 19):

a) by constant voltage/constant current crossover,

b) by decreasing output voltage as current increases (otherswise known as automatic current limiting), and

c) by decreasing both voltage and current as load resistance decreases (otherwise known as foldback or cutback current limiting).

7.9.1 *Current Limiting Threshold* — The value of the output current at which the stabilized output quantity falls outside the load effect band or tolerance band (whichever is specified) as the load resistance decreases.

7.9.2 *Maximum Limited Current* — The largest steady-state value of output current which the power supply delivers while in the current limiting mode.

NOTE — This value may not necessarily be allowed continuously.

7.9.3 *Short-Circuit Current* — The steady-state current delivered by a constant voltage power supply when its output terminals are short-circuited.

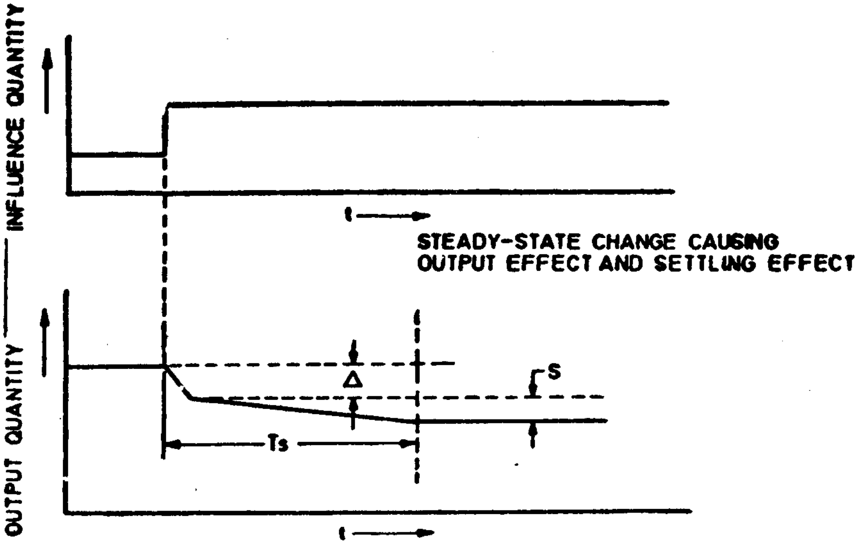
7.10 Voltage Limiting — The action of limiting the output voltage of a constant current supply to some predetermined maximum value (fixed or adjustable) and automatically restoring the output current to its normal value when the load conditions are restored to normal. There are two types of voltage limiting, namely (*see* Fig. 6 on page 19):

a) by constant voltage/constant current crossover, and

b) by decreasing output current as voltage increases (otherwise known as automatic voltage limiting).

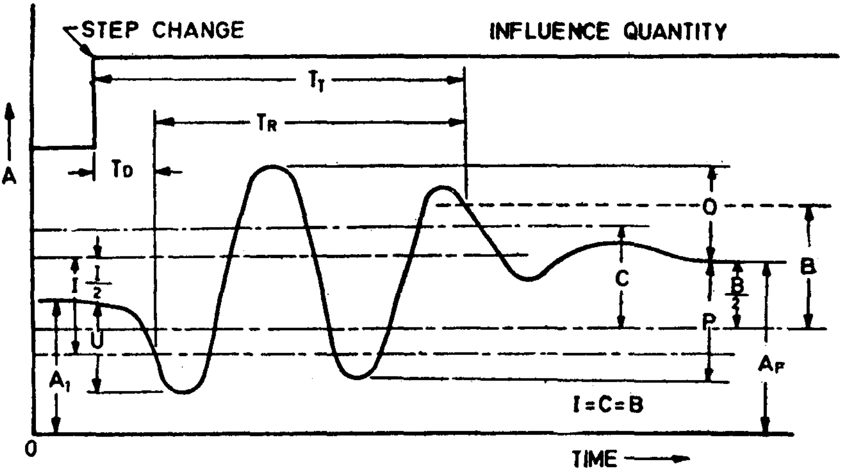
7.10.1 *Voltage Limiting Threshold* — The value of the output voltage of a constant current power supply at which the stabilized output current falls outside the load-dependent effect band or tolerance band (whichever is specified) as the load resistance increases.

7.10.2 *Open Circuit Voltage* — The voltage at the terminals of a constant current power supply when there is no load connected.

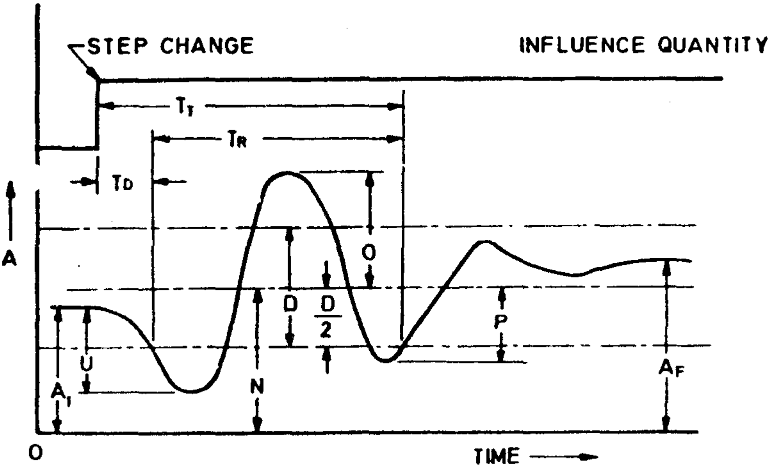

OUTPUT QUANTITY —— INFLUENCE QUANTITY
t
STEADY-STATE CHANGE CAUSING
OUTPUT EFFECT AND SETTLING EFFECT
Δ
S
Ts
t

Δ — Output effect
S — Settling effect
T_s — Settling time

FIG. 1 SETTLING EFFECT



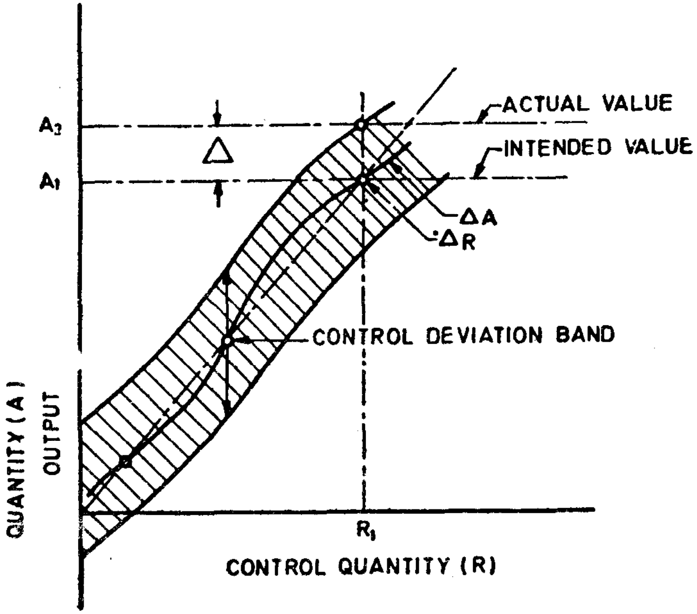
2A When Transient Initiation Band and Transient Recovery Band are Specified



2B When Tolerance Band is Specified

A — General output quantity
B — Transient recovery band
C — Output effect band
A_1 — Initial value of output quantity
A_F — Final value of output quantity
I — Transient initiation band
D — Width of tolerance band
N — Nominal value
O — Maximum overshoot amplitude
P — Negative overshoot amplitude
T_D — Transient delay time
T_R — Transient recovery time
T_T — Total transient recovery time
U — Undershoot amplitude

FIG. 2 TRANSIENT TERMS



α — Control coefficient $= \frac{R_1}{A_1}$

$\triangle$ — Control deviation $= A_2 - A_1$

ϕ -- Incremental control coefficient $= \frac{\triangle A}{\triangle R}$

FIG. 3 RELATIONSHIP OF CONTROL TO OUTPUT QUANTITIES

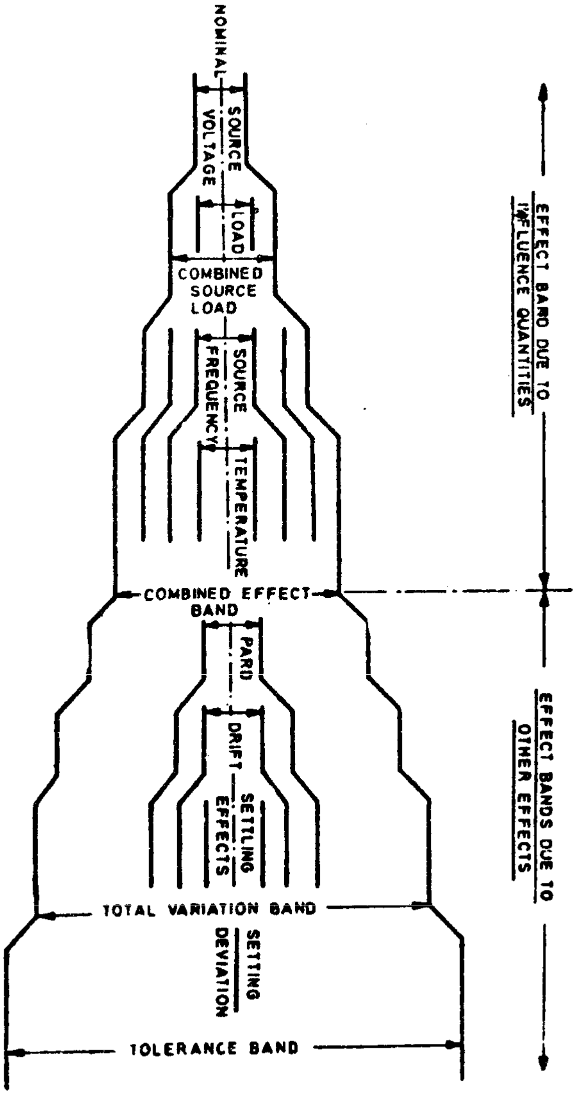
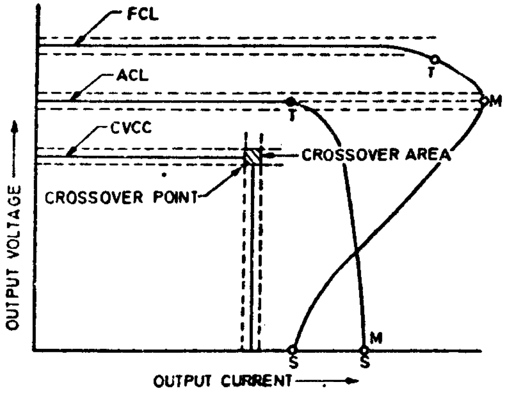


Fig. 4 The Relation of Effect Bands to Tolerance Band



CVCC — Constant voltage/constant current
ACL — Automatic current limiting
FCL — Foldback current limiting
T — Current limit threshold
M — Maximum limited current
S — Short circuit current

FIG. 5 TYPES OF CURRENT LIMITING

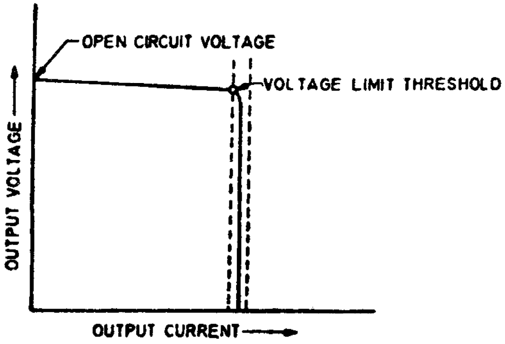


FIG. 6 VOLTAGE LIMITING IN A CONSTANT CURRENT SUPPLY

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